

Answers to Section 9.3 Review Questions

(Student textbook page 617)

1. Fluorine is the most electronegative element in the periodic table. Therefore, it does not “lose” electrons in chemical bonds. It has seven valence electrons, and thus forms bonds in which it gains one valence electron, satisfying the octet rule. Because it is in the second row of the periodic table, its outer occupied energy level cannot accommodate more than eight electrons (as bromine, iodine, or chlorine can). Therefore, it does not form bonds in which it gains more than one electron, and its oxidation number is always -1.
2.
 - a. MnO_2 +4
 - b. +7
 - c. + 6
 - d. KMnO_4 +7
3. Zero in the diatomic molecule, $\text{O}_2(\text{g})$; -1 in peroxides, $\text{H}_2\text{O}_2(\text{aq})$; -2 in most anions, $\text{CO}_3^{2-}(\text{aq})$; +2 in an oxygen difluoride, $\text{OF}_2(\text{g})$
4.
 - a. yes
 - b. no
 - c. no
 - d. yes
5. Students may suggest definitions similar to the following:
 - A redox reaction is a chemical reaction in which there is a change in the oxidation number of some or all of the atoms of the reactants.
 - A redox reaction is a chemical reaction in which atoms of one element are oxidized and atoms of another element are reduced.
 - A redox reaction is a chemical reaction in which electrons are transferred among reactants. The number of electrons gained by the oxidizing agent must equal the number of electrons lost by the reducing agent.
6. When one element combines with another element in a chemical reaction, the reaction is always a redox reaction. The atoms in uncombined elements have an oxidation number of 0. However, different elements have different electronegativities. Therefore, when they combine in a compound, atoms of the less electronegative element are oxidized and atoms of the more electronegative element are reduced.
7. The total increase in oxidation numbers corresponds to the number of electrons lost by oxidation. The total decrease in oxidation numbers corresponds to the number of electrons gained by reduction. In a reaction, net gain of electrons must be equal to net loss of electrons. Thus, the total increase in oxidation numbers must equal the total decrease in oxidation numbers.
8. $4\text{NH}_3(\text{g}) + 7\text{O}_2(\text{g}) \rightarrow 4\text{NO}_2(\text{g}) + 6\text{H}_2\text{O}(\ell)$
9.
 - a. +2
 - b. Using a Lewis structure, students may arrive at two different oxidation numbers for sulfur using the following reasoning. The central sulfur atom usually has 6 electrons in its valence shell. The three oxygen atoms, however, have a greater electronegativity than sulfur. Therefore, they can

be considered to have taken these electrons, leaving the central sulfur with a +6 oxidation number. The sulfur atom bonded to the central sulfur atom may be considered to share its electrons with the central sulfur. Therefore, it will have an oxidation number of -1. Since the central sulfur (+6) can now be considered to have one shared electron it will have a total oxidation number of $+6 + (-1) = +5$.

c. Using the first method, the oxidation number for both sulfur atoms is +2. Using the second method, the oxidation number for one sulfur atom is -1, and for the other is +5. (Notice the average of the second result gives the first result).

d. Using Lewis structures allows for the fact that atoms of the same element in a molecule or polyatomic ion may have different oxidation numbers, depending on the bonding arrangement. The disadvantage to this method is that it is more difficult and time-consuming than using the rules.

e. The advantage to using the oxidation number rules is that they apply to most cases and are quick and easy to use. The disadvantage to using these rules is that they do not allow for the possibility of different oxidation numbers for the same atoms in a molecule or polyatomic ion.

12. Oxidation numbers are values assigned to elements in a redox reaction to keep track of changes in charge. This system of book keeping is developed on a base of assumptions, that may seem arbitrary at times, but in fact do allow for the tracking of changes in charge.